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PROGRAMMABLY TIMABLE PRIMING DEVICE

BACKGROUND OF THE INVENTION

1. Field of Invention

The invention relates to the field of electrical firing mechanisms and priming devices of an ignition detonator for miniature bombs, projectiles, missiles, and mines, having an electrical power supply and means for timing the action of a firing element of a primer.

2. Description of Related Art

It is known to use priming devices having means for timing the action of a firing element of the primer.

Timing means are generally electronic, and failure thereof can result in premature action of the element on the primer, and thus in explosion of the weapon with which they are associated. It is self-evident that the explosion can have serious consequences for the user or users.

To avoid this problem, French Patent No. 2 670 576 describes a neutralization device for weapons, having a housing, a pyrotechnic chain deactivated by mechanical safety means (in this instance a clock), and a timer which can be controlled by transmission means.

A device of this kind has a drawback, however, when it is desired to prime several neutralization devices simultaneously. The reason is that each of the timers must be programmed while taking into account the time used to program the previous ones. Such programming cannot therefore be other than imprecise, and leads to successive explosions because it does not allow for multiple simultaneous firings.

SUMMARY OF THE INVENTION

The invention remedies these drawbacks by providing a reliable electronic or electromechanical priming device, the timing system of which can be programmed simultaneously for multiple priming devices with the aim of achieving perfect synergy.

According to the invention, a priming device of a detonator therefore has an electrical power supply providing a first current to a circuit having means for timing the action of a firing element of a primer and to means capable of generating, upon expiration of the timing interval, a second current sufficient to actuate the element, the first current emerging from the power supply not being sufficient.

According to an exemplary embodiment, the means includes a capacitor, switching means, and means for controlling the switching means allowing the capacitor to be charged for a charging time, then discharged, the discharge causing the element to act on the primer.

According to another exemplary embodiment of the invention which allows numerous associated devices to be added, a priming device of a detonator has an electrical power supply means for timing the action of a firing element of a primer, and means capable of generating, upon expiration of the timing interval, a current sufficient to actuate the element, the generating means having a capacitor, switching means, and means for controlling the switching means allowing the capacitor to be charged for a charging time, then discharged, the discharge causing the element to act on the primer, the control means comprising a microcontroller.

In addition, the switching means may include, for example, transistors.

In order to improve the operating flexibility of the device, the timing means may include means for programming the timing interval; the means can be entirely or partially integrated into the priming device. The means may include, for example, code wheels or a microcomputer.

According to another exemplary embodiment, the means includes external means having an electrical power supply, a microcontroller, a display, two programming switches, and transfer means including phototransistors.

According to another exemplary embodiment capable of preventing neutralization of the weapon by an unauthorized person, or of deliberately anticipating firing, a priming device according to the invention has booby-trap means which may include a circuit including switching means, the opening of which causes the primer to fire.

Lastly, another exemplary embodiment of the invention is a method for safing a priming device of a detonator, of the type having an electrical power supply and means for timing the action of a firing element of the primer, wherein the method includes, upon expiration of the timing interval, charging a capacitor and then discharging it to cause firing.

BRIEF DESCRIPTION OF THE DRAWINGS

Other advantages and features of the invention will be apparent from the description of various exemplary embodiments with reference to the attached drawings, in which:

Figure 1 depicts a simplified general diagram of the device according to the invention;

Figure 2 shows a diagram of the principal programming means;

Figure 3 depicts another exemplary embodiment of the invention;

Figure 4 shows a diagram of the external programming means according to another exemplary embodiment of the invention; and

Figure 5 shows a particular embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Figure 1 shows a diagram of a firing device of a primer of a detonator according to the invention. The firing device may be, for example, of the type having a housing within which are arranged an electrical power supply 10 for a circuit including a priming resistor 12 of a primer 13, a circuit closing means 20, and a means 30 for timing firing after the circuit is closed.

The power supply 10 may include, for example, two lithium batteries supplying a voltage of 6 V.

In this embodiment, the circuit closing means 20 may include, for example, a mechanical bolt 21, having two positions A and C, which is connected to a U-shaped key 22 placed in a constriction on the ~~exterior~~ of the housing, rotation of which allows the bolt 21 to be placed in the desired position.

As shown in Figure 2, firing timing means 30 includes a means 32 for programming a timing interval, a means 34 for switching the circuit which supplies power to the priming resistor 12, and a capacitor 36 supplying a current I2 as it discharges, a current I1 of the charging current of the capacitor 36 being insufficient to cause firing of the primer 13.

In this embodiment, the programming means 32 comprises code wheels 38 and a microcontroller 40. The code wheels 38 are luminescent, allowing programming both at night and during the day.

The microcontroller 40 controls the opening and/or closing of the switching means 34.

As shown in Figure 3, the switching means 34 includes first means including an electromechanical assembly 41 including, for example, a mechanical clock, associated with a mechanical changeover switch which is normally in the open position and which closes the circuit upon expiration of a predetermined operating interval of the clock.

A second means including a transistor 50 whose source is connected to the power supply 10, its gate to the microcontroller 40, and its drain to the input of the changeover switch of electromechanical assembly 41, and a transistor 55 whose source is connected to the priming resistor 12, its gate to the microcontroller 40, and its drain to the output of the changeover switch.

A third means includes a timed-closure switch 65 arranged between the power supply 10 and the microcontroller 40.

In addition, the drain of the transistor 50 is connected to a short-circuit transistor 60 which is in turn connected to the microcontroller 40 and to ground.

Moreover, resistors 70, 71, 72 limiting the current are located in the circuit upstream from the electromechanical assembly 41 and between the microcontroller 40 and the transistor 55, so that in the event the transistors 50 and 55 and the electromechanical assembly 41 fail, the current passing through priming resistor 12 is insufficient to cause priming of the detonator.

Furthermore, signaling means 81 and 80 are arranged respectively downstream from the timed-closure switch 65 and in parallel with the priming resistor 12.

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Lastly, generating means 35 including powersupply 10 and capacitor 36 are capable of generating, upon expiration of the timing interval, the current I2 sufficient to actuate the priming resistor 12, the power supply 10 providing the current I1 capable of charging the capacitor 36 and the capacitor 36 supplying the current I2 when it discharges.

With this embodiment, in which the programming means 32 includes code wheels 38, when the mechanical bolt 21 is in position A all the electronic means are grounded; while in position C, all the electronic means are powered, but the capacitor 36 is not in any case connected to the power supply circuit until after a safety delay time generated by the electromechanical assembly 41.

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In a second exemplary embodiment, the programming means includes an external programming device 100 and information transfer means, by direct contact such as an RS232 connector, or of the transmission/reception type, for example using phototransistors 148 and 149. In this instance the circuit closing means includes a mechanical bolt 21 having three positions, A, B, and C: the position A in which all the electronic means are grounded; the position B in which capacitor 36 is grounded and power is supplied to the other electronic means; and the position C which follows position B and in which capacitor 36 is connected to the circuit after a safety delay time generated by electromechanical assembly 41.

The external programming device 100 may including a microcomputer of the portable type into which a program is loaded, the program allowing the user to indicate, in particular, the firing time either in the form of a date, which then requires entry of the programming date if it does not already exist in the microcomputer, or in

the form of a delay interval. After the user has confirmed the programming, the data is transferred via an RS232 connector to one or more priming devices simultaneously.

The external programming device 100 may also include an assembly including an electrical power supply 110, a microcontroller 140, a display 145, two programming switches 146, 147, and a run/stop switch 112; and the transfer means including phototransistors 148, 149 associated with phototransistors 48, 49 arranged in the housing.

In this case, selection of parameters is accomplished via a preprogrammed drop-down menu. Data are displayed in blocks, and all the parameters associated with a block appear alongside one another, so that an overall view of the progress of each one is retained while programming the block.

There are four blocks, as follows:

DATE: corresponding to the programming date

DIRECT: the timing interval prior to priming of the detonator

CALENDAR: the date on which priming is to occur

TRANSMIT: validation of this block causes the programmed data to be transferred to the igniter.

As regards the two switches 146, 147, the function of one is to validate the data entry that is displayed and to display the first datum of the next parameter, which can be in the same block or the first one of the next block.

A booby-trap module 200, of the contact-opening type, is also added to the means described in the aforementioned first exemplary embodiment. The module 200 includes a closed circuit, powered by the power supply 10 described above, and includes a number of contactors whose method of opening depends on the type of

booby-trapping, which are connected to the microcontroller 40. As an example, the contactors can be opened by remote control, or can be inertial, or can more simply be a tripwire resting on the ground in the vicinity of the igniter.

A device according to the invention, programming of which is accomplished by way of the external programming device 100, operates as follows:

The batteries are placed in the housing before it is used, and mechanical bolt 21 is in position A, circuit closing means 20 and firing timing means 30 thus not being supplied with electrical power.

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The user then disengages key 22 from the constriction on the housing, then proceeds to turn the key 22 to position B in which capacitor 36 is grounded and power is applied to the other electronic means. The two phototransistors 48, 49 are located as close as possible to a portion of the housing which is transparent to the radiation emitted by phototransistors 148, 149 of the external programming device 100. The housing also has a notch which allows the respective phototransistors 148, 149 of the external programming device 100 and the firing means to be positioned precisely opposite one another.

Once the run/stop switch 112 has been closed, the microcontroller 140 of the external programming device 100 causes a menu to drop down, displayed block by block on the display 145, the transition to the next parameter of one block or to the next block being accomplished by actuating one of the programming switches 146, 147, the other programming switch serving to validate the parameters and transmit them to the firing device.

The menu can, for example, have two blocks, one corresponding to the desired timing interval D1 in a day/hour/minute/second format, i.e. four parameters, and the

other corresponding to the validation of the parameters and transmission of said parameters via the phototransistors 148, 149, 48, 49.

When all the parameters have been validated, validation of the TRANSMIT block causes the parameters to be transferred from the external programming device 100 to the priming device. In return, the microcontroller 40 sends back a copy of the parameters which is received by the external programming device 100, which verifies that they conform to those sent out previously, and issues a confirmation message releasing the transmission.

It is evident that when the priming time is selected in calendar mode, it is possible to transmit the same parameters, successively or simultaneously, to a plurality of priming devices, and thus to synchronize all the priming events.

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The use of a microcomputer makes this synchronization operation even easier. All that is necessary is to connect the microcomputer to each of the RS232 connectors of the various priming devices being synchronized, and then to transfer the parameters simultaneously to all the devices.

The firing means are then placed on a suitable explosive device. In the case of a mine, it can be placed on the target to be destroyed, by the user, who then proceeds to turn key 22 to position C and then withdraws it from the housing to prevent any access by an unauthorized person to bolt 21.

In this position, the countdown of the timing interval D1, which began when the transmission was released, continues, while the mechanical timing clock of the electromechanical assembly 41 is triggered. Upon expiration of a preprogrammed operating time Tp1 of the clock, it causes the electromechanical assembly 41 to trip,

and thus causes closure of the portion of the circuit located between the transistor 50 and the capacitor 36.

Thus, in all cases in which timing interval D1 programmed by the user is less than preprogrammed time Tp1, or in cases where the microcontroller 40 or the transistors 50, 55, 60 fail, firing cannot in any case take place until after the time Tp1 has elapsed.

After value D1 has counted down, the microcontroller 40 deactivates the short-circuit transistor 60 and activates the transistor 50 which then becomes conductive. The capacitor 36 then charges, and after a preprogrammed time Tp2, called the capacitor charge time, has elapsed, the microcontroller 40 activates the transistor 55 which becomes conductive, thus allowing the capacitor 36 to discharge through the transistor 55 and through the priming resistor 12, the current I2 passing through the priming resistor I2 being sufficient to cause priming of the detonator.

Allowing the capacitor 36 to charge only upon expiration of a timing period increases the reliability of the device, since no capacitor leakage current is present during that period.

Be it also noted that for safety reasons, it is preferable for capacitor charging time Tp2 to be long as compared with its discharge time. Any malfunctions which would be expressed as simultaneous actuations of all the transducers (such as EMP or nuclear effects) would thus have no consequences.

In addition, the process of charging the capacitor 36 can of itself meet a need for nondegradable safety. The safety time is then just shorter than the time which results in a significant capacitor charge, i.e. one capable of causing firing of the primer when it discharges. It can be adjusted via the charging current. In this case the

electromechanical assembly 41 is not necessary, whether capacitor charging is performed at power-up or before firing. In applications in which the safety time is very long and/or when the booby-trap module 200 is used, however, utilization of electromechanical assembly 41 is required.

Especially when the programming means 32 includes the coding wheels 38 and the microcontroller 40, the timed-closure switch 65 can be inserted into the circuit so as to generate an additional safety delay Tp3 before any firing when the user turns the key 22 from position A to position C. In this embodiment, this delay is an operational safety delay: during this delay time, which is an integral part of interval D1, all the switching functions of the transistors 50, 60, 55 of the microcontroller 40 are inhibited.

Concurrently, the mechanical timing clock of the electromechanical assembly 41 is triggered. Upon expiration of a preprogrammed operating interval Tp1 for the clock, it causes the mechanical changeover switch associated with the electromechanical assembly 41 to trip, thus causing closure of the portion of the circuit located between the transistor 50 and the capacitor 36.

The closure switch 65 and the clock thus form two simultaneously triggered safety elements of different types: one electrical, which acts on the microcontroller 40; and the other mechanical, which acts on the capacitor 36, such that priming of the detonator cannot occur prior to the higher value of times Tp1 and Tp3.

Another operating mode of the device described above includes authorizing firing of the primer 13 via the booby-trap module 200 upon expiration of the longer of delays Tp1 and Tp3, specifically during the entire programmed timing interval; and, if applicable, in inhibiting the transistors 50 and 55 when the timing interval elapses,

thus rendering the device inert and recoverable. The reaction time between actuation of the booby-trap module 200 and firing of the primer 13 is, in this case, equal to Tp2.

According to another exemplary embodiment of the invention, the timing means can be simplified as depicted in Figure 5. The priming device then comprises an electrical power supply 310 (batteries, for example, in this instance), a timed-opening relay 330, a timed-closure relay 335, a capacitor 336, and the priming resistor 12 of the primer 13.

As soon as the batteries are inserted, the two relays 330 and 335 are energized. Since the relay 330 is initially closed, the capacitor 336 charges. The relay 330 opens after an interval Tp4, then the relay 335 closes and the capacitor 336 then discharges into priming resistor 12, causing firing of the primer 13.

In the case of priming by displacement of a mechanical element, discharge of the capacitor 336 supplies power to a solenoid, activation of which causes release of the electromechanical element which primes the detonator.

As far as the booby-trap module 200 is concerned, accidental breakage of the tripwire, or opening of an inertial contactor when the priming device is moved, causes priming of the detonator. For safety reasons, however, priming cannot occur before the expiration of intrinsic safety time Tp1 and operational safety time Tp3, resulting from electromechanical means and/or timed switch 65.